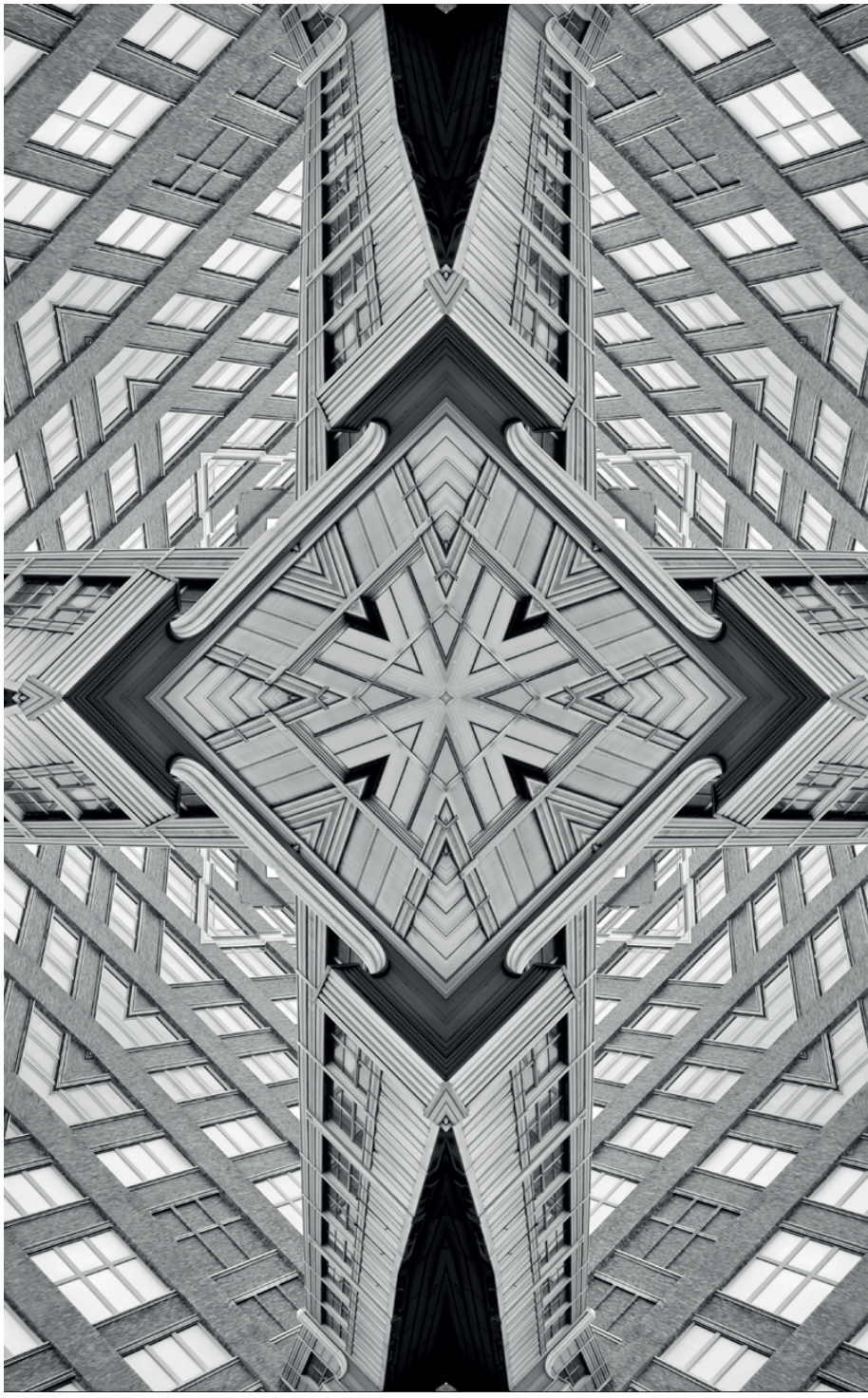
Issue Brief

ISSUE NO. 458
APRIL 2021

OBSERVER RESEARCH FOUNDATION



Preparing Indian Cities for a Shift to E-Mobility

Ramanath Jha

Abstract

India is driving a transition to e-mobility in a bid to meet its commitments to the Paris climate agreement. Meeting the e-mobility targets will have multiple benefits, including cleaner air, improved health, and a reduced oil import bill. India's cities will play a key role in achieving the e-mobility transition through planning and the implementation of local policies, but they must first overcome certain challenges. Assistance from the central and state governments and the automobile industry will be crucial to this process.

Attribution: Ramanath Jha, "Preparing Indian Cities for a Shift to E-Mobility," *ORF Issue Brief No. 458*, April 2021, Observer Research Foundation.

Introduction

India's thrust towards e-mobility partly stems from its overall environmental commitments under the Paris climate agreement to reduce greenhouse gases, transition quickly to clean energy and contribute to the mitigation of the aftereffects of climate change. The Paris Agreement,[1] an international treaty on climate change, comprised environmental commitments by various countries and was adopted by 196 parties at the 21st Conference of Parties on 12 December 2015 and came into force as a legally binding agreement on 4 November 2016. As a signatory to the climate pact, India has committed to reducing emission intensity[a] by 33 percent to 35 percent by 2020 from 2005 levels. Additionally, India has pledged to increase non-fossil-based energy resources to 40 percent of installed capacity by 2030.[2] In December 2020, at a side meeting on climate change at the G20 Summit, Indian Prime Minister Narendra Modi declared that the country is exceeding its agreed commitments[3]—India's installed capacity of renewable energy has gone up by 226 percent in the past five years and is on track to achieve its nationally determined contributions (NDCs) under the Paris Agreement.[4]

India has undertaken several initiatives to push for the increased adoption and use of electric vehicles (EVs). For instance, it is a participant country in the EV30@30 Campaign, a Clean Energy Ministerial initiative, which aims for the sales share of EVs to reach 30 percent by 2030.[5] The campaign supports the market for electric passenger cars, light commercial vans, buses and trucks (including battery-electric, plugin hybrid, and fuel-cell vehicle types) and focuses on the charging infrastructure needed to supply sufficient power to the vehicles deployed. India has a more ambitious EV target—by 2030, it expects 70 percent of all commercial cars, 30 percent of private cars, 40 percent of buses, and 80 percent of two-wheeler and three-wheeler sales to be electric (although this is a revision of the previous aim of having only EVs on the road by the start of the next decade).[6] To achieve this goal, India will need a substantial number of in-home charging points and 2,900,000 public charging points, a considerable increase from the current 1800 and which will require an additional investment of INR 20,600 crore.[7]

The National Electric Mobility Mission Plan (NEMMP) 2020[8] outlines the vision and roadmap for the faster adoption and manufacturing of EVs in India. Under the NEMMP, the Department of Heavy Industry formulated the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India, better known as FAME India, in 2015 to promote the development and sustainable growth of electric and hybrid vehicle technologies.

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a Emission intensity is the level of greenhouse gas emissions per unit of economic activity, usually measured at the national level as GDP. Reducing emission intensity means that less pollution is being created per unit of GDP.

Several states have prepared their own EV policies, including Andhra Pradesh, Bihar, Delhi, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Tamil Nadu, Telangana and Uttar Pradesh.[9] Although most of these policies prioritise public transport, paratransit and job creation, they differ in terms of targets and supply-side (manufacturing) and demand-side (consumer and charging infrastructure investments) incentives. Kerala, for instance, offers incentives in the form of tax breaks, road-tax exemptions, toll-charge exemption, free permits for fleet drivers and free parking. On the other hand, Bihar provides subsidies of INR 12,000 to the end-user and an additional special incentive of INR 10,000 for lithium-ion battery e-rickshaws. Delhi offers a maximum incentive of INR 30,000 per vehicle for scrapping and de-registering old and highly polluting two-wheelers.[10]

In addition to these state policies, many cities have prepared Comprehensive Mobility Plans (CMPs), either independently or with the assistance of the central government.[11] Mumbai and Pune in Maharashtra have prepared CMPs unassisted, while Tumkur, Davanagere, Shimoga, Mangalore, Mysuru, Belgaum, Bellary, Gulbarga, Hubli-Dharwar, Bidar, Chitradurga, Bijapur, Hospet and Raichur in Karnataka, and Amritsar, Bhatinda, Jalandhar, Pathankot and Patiala in Punjab have done it with central government support. Cities are a key cog in the move to EVs since the ultimate implementation must happen at the local government level. But the transition to EVs at the city level will likely come with several challenges, such as coordination between departments, synchronisation of action, and financial and spatial constraints.

> “India’s installed capacity of renewable energy has gone up by 226 percent in the past five years and is on track to achieve its commitments to the Paris Agreement.”

A substantial contribution to India's NDCs must come from the reduction of vehicular emissions. India is currently the fifth-largest car market globally and appears set to become the third largest soon.[12] Before the COVID-19 pandemic, it was estimated that "by 2020, the annual demand for passenger vehicles, commercial vehicles and two wheelers in India will be 10 million, 2.7 million and 34 million respectively, thereby making India the third largest vehicle market in the world".[13] This anticipated growth in passenger vehicle usage will lead to a rise in the demand for fossil fuels and likely result in other adverse environmental impacts. Given that India is largely dependent on oil imports to meet its energy needs, the increase in the number of vehicles will also raise the import bill, with undesirable economic consequences. On the other hand, EVs will substantially reduce fuel import costs, lower emissions considerably, and have an overall vital role in India meeting its NDCs.

To achieve its e-mobility goals, India must revise its transportation strategy to focus on public transport (primarily e-buses and rail-based systems) instead of private. The "country needs a transportation revolution. The current trajectory of adding even more cars running on expensive imported fuel and cluttering already overcrowded cities suffering from infrastructure bottlenecks and intense air pollution is unfeasible. India's cities will choke".[14] Currently, the transport sector contributes an estimated 142 million tonnes of CO_2 annually, of which 123 million tonnes are from the road transport segment alone.[15] On the other hand, an emphasis on public transport and the resultant reduction of CO_2 will significantly enhance the city environment and livability.

India's e-mobility push will also have positive impacts far beyond the environment. E-mobility can catalyse India's digital and consumer product innovation and help modernise the conservative manufacturing industry. The Department of Science & Technology has established a platform to develop technologies and products addressing Indian needs and a global competitive edge in certain e-mobility technologies. The priority areas of innovation include lithium-ion battery, motors and drives and ultracapacitors.[16] E-mobility will also make a positive contribution to balancing energy demand, energy storage and environmental sustainability.[17] An increase in the number of EVs will raise the share of solar energy in the energy mix. It would also mean an increase in rechargeable batteries that could serve as electricity storage devices, allowing grid operators to supply it back to the grid in case of an unstable power supply.[18] "Electric vehicles could help diversify the energy needed to move people and goods thanks to their reliance on the wide mix of primary energy sources used in power generation, greatly improving energy security."[19]

India's EV market is estimated to grow to nearly US$206 billion (INR 14,42,200 crore) by 2030, with investments of over US$180 billion (INR 12,50,000 crore) needed for vehicle production and charging infrastructure to meet the country's EV ambition.[20] Cumulative EV sales in all vehicle segments are expected to cross over 100 million units by 2030, which is 200 times its current market size, and realising the EV ambition will require an estimated annual battery capacity of 158 GWh by the end of the decade.[21] In addition to equipping urban hubs for the e-mobility transition, India must also prepare its Tier 2 and Tier 3 cities to use EVs by installing and upgrading their EV infrastructure. Substantial investments will be required to make these cities EV-compliant, and their governance architecture will need to be refurbished to enhance local capacities to deal with the transition. Currently, skilled workforce in the smaller local bodies and the cross-departmental interconnectivity required to handle the transition to e-mobility either do not exist or are not sufficiently understood. These gaps need to be plugged quickly through capacity building and administrative realignments. Given this situation, the previous target of having only electric cars by 2030 was impractical. As was the assertion by the Minister of Transport in 2018 at the annual convention of the Indian Automobiles Manufacturers: "We should move towards alternative fuel. I am going to do this, whether you like it or not. And I am not going to ask you. I will bulldoze it."[22]

The EV sector in India faces two major roadblocks. First is the workforce issue. It is estimated that due to greater automation if a switch to 30 percent electric cars out of all vehicles on roads is achieved, workforce requirements will decrease by 20 percent to 25 percent. Additionally, the skill set for EVs are different; EV-related jobs will require a specially-trained workforce capable of handling the new skills, which does not exist in India today.[23]

Second, Indian customers appear to have several reservations about using EVs. Currently, EVs are substantially more expensive than conventional cars, which is a disincentive for most Indian buyers (who are highly price-conscious[24]). Additionally, most available EVs have a short driving range and relatively slower speed, although, with newer technology, automakers are developing cars that can run longer and faster.[25] Consumers are also likely keen to use EVs that can travel a long distance on a single charge and have easy access to charging stations along their travel routes, but the current paucity of charging stations is a probable deterrent to EV adoption. The amount of time needed to charge an EV (multiple hours compared to the few minutes needed to refuel) is also a factor that could influence consumers' purchasing decisions. Finally, if a consumer wants to sell their EV after some years of use, they may encounter some difficulties in finding a buyer to pay a reasonable price (an issue that is rare when selling used conventional vehicles).[26]

Cities and E-Mobility: Addressing the Challenges

Among the several stakeholders in the transition to e-mobility (technology providers, manufacturers, customers, and central, state and local governments), cities have a predominant role in its success. The world is increasingly urbanised, with the global urban population estimated to grow by 65 million annually.[27] Cities also generate a significant portion of the global economy (80 percent), with the top 600 cities contributing about 60 percent of the global GDP.[28] Cities also house and operate a substantial share of all in-use automobiles, consume over two-thirds of the world's energy and emit over 70 percent of global CO_2, meaning their climate footprint is enormous.[29] This is why cities, aided by provincial and federal governments and the automobile industry, will be the determining factor in the success of the EV transition.

> "Cities—home to a large number of all in-use automobiles and which have an enormous climate footprint—will determine India's success in EV transition."

Several global cities have made considerable progress on adopting EVs, including in the US, China, South Korea and Europe.[30] A 2017 study on the number of EVs in cities across the world revealed that nearly a third sales were in just 14 cities (Oslo, Utrecht, Shanghai, Shenzhen, Amsterdam, San Jose, San Francisco, Copenhagen, Beijing, Stockholm, Zurich, Los Angeles, Paris and London).[31] Additionally, 14 European and North American national, state and provincial governments have committed to zero-emission vehicle sales by 2050.[32] While Beijing, Los Angeles and Shanghai have higher EV sales in absolute numbers (as of 2018), 39 percent of all new cars in Norway's Oslo are electric, earning it the moniker 'EV capital of the world'.[33] In 2017, more than 50 percent of all cars sold in Oslo were either fully battery electric or a plug-in hybrid, likely due to incentives such as green taxes. Significant progress was also made on the infrastructure front, with the number of charging stations across Norway increasing from 7,000 in 2015 to 16,000 by 2020.[34] At the same time, Chinese cities are the largest EV markets globally, with Shanghai, Shenzhen, Beijing, Tianjin, Weifang and Liuzhou each accounting for an over 15 percent EV sales share in 2018.[35]

Like their global counterparts, Indian cities will have to play an important role in the country successfully meeting its NDCs. India's EV industry is currently in a nascent stage—in 2018, EVs accounted for less than 1 percent of total vehicle sales, including 0.4 million electric two-wheelers.[36] Indian cities will face several challenges in the transition to e-mobility.

Financing

First, bus fleets in Indian cities must be changed into electric ones, with adequate charging infrastructure. India currently faces a substantial shortfall in the number of buses needed to meet consumer demand. In 2018, India had 19 lakh buses, of which only 2.8 lakh were run by state transport undertakings or under stage carriage permits. Conservatively, at least 30 lakh buses are needed to meet the demand.[37] This shows there is great scope to promote public transport and meet e-mobility goals, but considerable investments will be needed. Most cities that run their own public bus transport undertakings may not find the money in their budgets and require state and central assistance. Even cities with state-run bus services will require investment to transition to electric buses. The private sector can help bridge this gap on a public-private partnership platform. Green bonds—debt securities issued by financial, non-financial or public entities, the proceeds of which are used to finance 100 percent of green projects and assets—could also be a viable financing option for EVs. Green bonds, like conventional bonds, can mobilise resources from domestic and international capital markets but for investment in environmental projects alone. The issuer, however, needs to repay interest and capital.[38] India now has the second-largest emerging green bond market after China,[39] highlighting the potential of this financing avenue.

Charging Infrastructure

The second challenge is erecting an extensive network of EV charging stations. In 2016, India had fewer than 500 EV charging stations, concentrated in cities like Delhi, Mumbai, Bengaluru and Kolkata,[40] rising to just 993 at the end of July 2020.[41] By 2030, Delhi alone is estimated to need around 300,000 high-speed charging stations, assuming a 30-percent EV penetration into an approximate car population of 10 million,[42] needing an investment of about US$1.5 billion (about INR 11,000 crore).[43] Several measures can be undertaken to provide this infrastructure, such as installing charging stations where cars are already being parked (residential parking lots, taxi stands, bus stands), and encouraging individual owners with space and the ability to erect charging stations to do so to reduce the load on public charging stations. According to the Ola Mobility Institute, a scientific approach is needed in developing charging infrastructure. "Placing the right number of stations at the right place is the key for maximizing the utilization of the station as well as ensuring ease of access for customers. In order to appropriately evaluate a spot for one charging location we need to take into account a host of parameters like traffic, land cost, power supply, vehicle mix etc……. Hence, a clear data-driven, research-backed and mathematical

optimization-based solution is needed which will account for multiple realistic scenarios and come up with the best possible recommendation. Given the large upfront investment of this undertaking and policy priority from the government, we need to get it right from the get go in order to maximize benefits to all the stakeholders and thereby to the society."[44]

A further issue is the speed of charging infrastructure. Slow chargers (3-4 kW)[45] require a long time to charge and could be a considerable disincentive for e-mobility adoption. Installing high-speed chargers (50-100 kW)[46] will need substantial investments and the expansion and strengthening of power grids to prevent disruptions (since high-speed chargers need more electricity). High-speed chargers also have additional safety issues. Internal chemical reactions in the battery while being charged are susceptible to ambient temperature. Heat release in tropical settings in the high-speed charging process can cause battery explosions, as happened in Malda in West Bengal in July 2020 when a battery-operated rickshaw exploded, killing the rickshaw driver.[47]

India has fairly progressive standards and guidelines on charging infrastructure, clearly aimed at incentivising the activity.[48] The guidelines allow private charging at residences and offices, housing societies, malls, office complexes, restaurants, hotels, and other venues. Setting up public charging stations has been declared a de-licensed activity and "any individual/ entity is free to set up public charging stations provided that, such stations meet the technical, safety as well as performance standards and protocols laid down below as well as any further norms/ standards/ specifications laid down by Ministry of Power and Central Electricity Authority (CEA) from time to time."[49] Any person who wants to set up public charging stations will be provided connectivity, and any charging station can get power from any distribution company. The guidelines also specify the public charging infrastructure requirements and standards for transformers, cables, civil works and adequacy of space. It further prescribes that at least one charging station shall be available in a grid of 3 km X 3 km, and that the tariff for domestic charging will be the same as for domestic consumption.[50]

> "The transition to EVs at the city level will likely come with several challenges, such as financial and spatial constraints, power availability and e-waste management."

Power Availability

E-mobility will also require additional power availability on existing grids, and India's current energy grid system will not be able to handle the additional demands of charging a large number of EVs at the same time. A mere 30 percent EV addition in two-wheelers and four-wheelers in Indian cities will require three percent to four percent more power generation capacity than normal.[51] One way to cause less impact on the power grid is to incentivise EV owners through low fees to charge at times when electricity usage is low (and similarly disincentivise through higher tariffs when power usage is high). Without a strong charging infrastructure (comprising accessibility, profitability, time required for charging, charging station location, time-based tariff), traditional car owners are unlikely to switch to EVs. The envisaged power distribution systems at the city level must deal with such issues of grid stability.

E-Waste Management

An additional challenge is in managing EV batteries at the end of their life cycle. At this point, battery waste comprises enormous amounts of chemicals such as cobalt, electrolytes, lithium, manganese oxide and nickel. However, Indian cities are not in a position to handle the large volume of EV battery waste that will accompany increased EV use. The sheer volume of battery waste that will emerge will require an enhanced spatial provision in cities to handle that waste. The country already struggles to handle its e-waste, given its low recycling ability; most e-waste is currently dumped in landfills, which is a hazardous way of dealing with such refuse. India must strengthen its existing e-waste management rules—the E-waste (Management and Handling) Rules, 2011; E-waste (Management and Handling) Rules, 2016; and E-waste (Management) Amendment Rules, 2018[52]—to cover EV batteries as well or risk its cities becoming dumping grounds for EV waste. A significant first step is India's vehicle scrappage policy that sets benchmarks for end-of-life vehicles and their disposal, assisting heightened sales of new, non-polluting vehicles equipped with upgraded safety features.[53] The policy also provides for scrapping facilities, material recovery and safe disposal of waste.[54]

India's e-waste policies have significant room for improvement in several key areas. There is poor information at the state and local level of the quantum of e-waste generated within the country and e-waste generated through imports per annum. For instance, India generated 3.2 million tonnes of e-waste in 2019, but the details of 90 percent of this waste went undocumented.[55] As a result, designing systems for effective collection, transportation and processing becomes difficult. While the informal e-waste sector provides livelihoods to

marginalised communities, the sector's waste management practices pose serious environmental and health hazards to the workers and the larger public. A better regulatory design and enforcement arrived at through engaging with all stakeholders is needed.[56]

India can learn from the European Union (EU) experience, which issued a directive to member states to "minimise the negative impact of batteries and accumulators on the environment, contributing to the protection, preservation and improvement of the quality of the environment".[57] According to the directive, EU member states shall promote research and encourage improvements in the overall environmental performance of batteries and accumulators throughout their entire life cycle and the development and marketing of batteries and accumulators that contain smaller quantities of dangerous substances or which contain fewer polluting substances, in particular as substitutes for mercury, cadmium and lead. Germany has placed a legal obligation on producers to collect their products from the consumer and deposit them in containers managed by the GRS Batteries Foundation, set up by leading battery manufacturers and the German Electrical and Electronics Industry Association in 1998. GRS then ensures the collected waste is segregated and sorted according to electrochemical composition to efficiently extract reusable materials like cadmium and lead for further battery production. Following the EU directive, several European cities have begun to view battery waste as a resource and have identified productive and innovative ways of reusing waste recoveries.[58]

Road Quality

The quality of city roads will also need to be upgraded since EVs weigh more than conventional cars due to the weight of the battery pack. Even in ordinary circumstance, city roads in India are in poor conditions and often disintegrate, especially in the monsoons. Road construction technology will need to account for the additional weight of EVs, especially buses, trucks and multi-axle vehicles. In addition to the heavy vehicle load, Indian roads must also be prepared to handle the regular overloading that commercial vehicles routinely indulge in, given the substantial enforcement deficits in the country.

Conclusion

Ramanath Jha *is Distinguished Fellow at ORF, Mumbai.*

India must make a switch to EVs to achieve its Paris goals, but substantial effort is required. All levels of government—central, state and local—and the automobile industry must have a common and coordinated action towards realising the EV goals, and must make the resources needed available for the transition. Urban local bodies will be critical in the e-mobility transition, and two vital areas will need strengthening—city governance and city finance. The city chief executive must make decisions on ground implementation to avoid the traps of red-tapism. Additionally, given the fragility of municipal finances, the central and state governments must enable adequate financing for EV infrastructure at the local level.

Several Indian cities are already preparing for an EV future. Mumbai is setting up charging stations at strategic locations, including retail malls, business hubs, highways and some neighbourhoods.[59] In August 2020, the Delhi government notified the Delhi EV Policy, 2020, to offer subsidies, road tax and registration fee waivers for EVs and disincentivise fuel-based vehicles by imposing a congestion fee.[60] In Bengaluru, 112 charging stations have been set up for EVs and to encourage citizens to switch to EVs from fuel-based cars.[61] Kolkata has planned 241 charging stations for EVs at the cost of INR 125 crore.[62]

At the same time, there is limited awareness—and many misgivings—among car users about EVs. City administrations and the automobile industry must inform consumers of the benefits of EVs and the planned infrastructure to allay their fears.[63] Outreach efforts could include conducting exhibitions, discount sales, information dissemination, deploying emission-savings calculators, cost-savings calculators, and the real-time monitoring of environmental and financial benefits.

If cities are able to perform their role in driving the EV transition, with adequate support from the Centre and states, India will quickly move to having environmentally sustainable and economically beneficial transport systems and achieving its climate goals. ORF

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Ideas . Forums . Leadership . Impact

20, Rouse Avenue Institutional Area,
New Delhi - 110 002, INDIA
Ph. : +91-11-35332000. **Fax :** +91-11-35332005
E-mail: contactus@orfonline.org
Website: www.orfonline.org